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MINUTES AND PROCEEDINGS

of the

ARMY-NAVY-OSRD VISION COMMITTEE

SIXTH MEETING - 12 OCTOBER 1944

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M I N U T E S   A N D   P R O C E E D I N G S

of the sixth meeting of the

ARMY - NAVY - OSRD VISION COMMITTEE

October 12, 1944

National Academy of Sciences
Washington, D. C.

~~CONFIDENTIAL~~

U. S. Armed Forces - NRC Vision
" Committee

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Major S. K. Guth, Engrs
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ARMY - NAVY - OSRD VISION COMMITTEE

MINUTES

Sixth Meeting
National Academy of Sciences
1000, 12 October 1944

The following were present:

ARMY	AAF	(A)Major Paul M. Fitts
		Lt. A. Chapanis, Aero Medical Laboratory, Wright Field
	AGO	(M)Dr. Edwin R. Henry
	QMG	(A)Capt. R. M. Toucey
	SG	(M)Lt. Col. W. L. Cook, Jr.
	WDLO	(M)Capt. Howard E. Clements
NAVY	CominCh	(M)Lt. Comdr. R. E. Burroughs
		(A)Lt. S. H. Britt
	BuAer	(A)Lt. Harry London
		Lt. (jg) R. G. Harmon, Special Devices Section
	BuMed	(M)Capt. J. H. Korb
		(A)Lt. Comdr. R. H. Peckham
		Lt. Comdr. E. C. Hoff, Research Division
		Lt. Harry J. Older, Aviation Psychology Section
	BuOrd	(CM)Lt. Philip Nolan
		Comdr. William C. Butler
	BuPers	Lt. (jg) John E. LeFevre, Training Aids Section
		Lt. J. J. McCarthy, Training Division
		Lt. J. C. Snidecor, Standards and Curriculum Section
		Lt. C. P. Stinson, Training Division
	BuShips	Lt. (jg) G. G. Hamaker
	I C Bd	(M)Lt. George Dyson
		Comdr. R. C. Peden
		Mr. Allen E. Swim
	NMRI	(CM)Dr. Harold F. Blum
		Lt. M. B. Fisher, Naval Medical Research Institute, Bethesda
	NRL	(M)Dr. E. O. Hulburt
		(A)Dr. Richard Tousey
	SONRD	(M)Lt. Comdr. H. G. Dyke
	SubBase	(M)Capt. C. W. Shilling
		(A)Lt. (jg) W. S. Verplanck
	ATC	Lt. R. E. Blackwell, Amphibious Training Command, Norfolk
		Lt. John H. Sulzman, Amphibious Training Command, Norfolk
	MFRL	Comdr. W. E. New, Medical Field Research Laboratory, Camp Lejeune
		Ens. Sherman Ross, Medical Field Research Laboratory Camp Lejeune

NTC Lt. H. B. McFadden, Naval Training School (Recognition), Ohio State University

N/Yd Lt. (jg) Frank C. Pfister, Jr., Receiving Station, Philadelphia Navy Yard

OSRD NDRC (CM)Dr. F. E. Wright
Dr. S. Q. Duntley, Technical Aide, Section 16.3, M.I.T.
APP (M)Dr. H. K. Hartline
Dr. W. C. H. Prentice, Project N-115, Princeton
Dr. Carl Wedell, Project N-115, Princeton
Dr. Dael Wolfle, Technical Aide
NRC (CM)Dr. Selig Hecht
OSRD (M)Dr. Donald G. Marquis

S/Ldr. E. A. G. Goldie, RAF Delegation
W/Cdr. P. A. Lee, RAF Delegation
Surg. Lt. Henry Z. Sable, Canadian Joint Staff

1. The chairman called for corrections or alterations in the Minutes and Proceedings of the fifth meeting. There were no corrections.

2. The secretary made the following announcements:
   A. In response to request from the Bureau of Aeronautics (Minutes, fourth meeting, p. 6, item 7) regarding methods for the optical inspection of curved plastic sheets, arrangements were made for consulting assistance by Dr. Wright and Dr. Hardy. Progress is being made in the development of a method by an industrial laboratory.
   B. The Navy Bureau of Ordnance has available a Mark IV stereo-trainer. Any individual or laboratory desiring this instrument for research or study may communicate with Lt. Comdr. Ballard.
   C. The Vision Committee has undertaken to cooperate with a project, under Dr. J. F. Fulton of the Committee on Medical Research, in the preparation of a Bibliography of Vision Literature, 1939-44. It is hoped that the final publication may be available early in 1945.

3. A request from the Engineer Board for information concerning the utility of fixed-focus optical instruments was presented for discussion. Specific questions considered 9*

*Numbers at the right refer to pages in the Proceedings on which the full report or discussion is presented.

were: (a) Have data been accumulated showing the range and distribution of normal diopter setting for military personnel? (b) Are adjustable eyepieces necessary? (c) What values of fixed focus will be most satisfactory, and what percentage of military personnel will be able to use such equipment?

4. The Bureau of Aeronautics requested the advice of the Committee on the use of tinted glass in control towers. Dr. Hulburt presented the question for discussion. 14

5. Captain Korb asked the Committee to consider recommending an investigation of the Dvorine method of corrective retraining of color blindness. After discussion, it was 15

AGREED: That the Vision Committee ask the American Medical Association Council on Physical Therapy to evaluate the Dvorine method for the correction of color blindness.

6. Dr. Hecht presented the results of his research on the effect of prolonged exposure to sunlight on night vision (Minutes, fourth meeting, p. 7, item 7). After discussion of the recommendations included in the report, the Committee 16

VOTED: To recommend that Dr. Hecht's work be continued and that measurements be made in the tropics to determine the light level and the effect of exposure to tropical light on day and night vision.

VOTED: To recommend that personnel required to perform visual duties at night after prolonged exposure to sunlight use, during daytime exposure, sunglasses or filters for optical instruments with transmission of not more than 15%.

7. An inquiry from AAF concerning the problem of ultraviolet radiation at high altitudes (Minutes, fourth meeting, p.6, item 4) has been considered by:

A. Dr. Blum, who discussed ultraviolet radiation at high altitudes and its biological effects, and 21

B. Lt. Comdr. Peckham, who discussed protection against ultraviolet radiation in plastic enclosures at high altitudes. 22

8. Lt. Comdr. Peckham prepared a report in response to a request from the Office of the Quartermaster General, recommending specifications for a heat-filter lens for the Variable-Density Goggle. 24

9. The report on the study of shipboard performance of night lookouts, Project N-115, Applied Psychology Panel (Minutes, fourth meeting, p. 7, item 9A) was presented by Dr. Prentice. 26

10. Dr. Wedell demonstrated a portable night vision testing and training device for shipboard use, developed by Project N-115. 30

11. Lt. (jg) Verplanck reported data on the performance of submarine lookouts, collected during recent observations with the Pacific Fleet. 33

12. Lookout training in the Navy was reviewed briefly by Lt. J. C. Snidecor. Copies of the U. S. Navy Standardized Curriculum, Lookout-Recognition for Recruits, and of the proposed requirements for the Navy designation, "Expert Battle Lookout," were distributed for discussion. After considering the most effective method for presenting the views of the Committee, it was 36

AGREED: That the chairman forward a digest of the discussion of the Expert Battle Lookout designation to the Bureau of Naval Personnel.

3. FIXED-FOCUS BINOCULARS AND TELESCOPES

The following inquiry was directed to the Committee by Major Guth for the Engineer Board:

> In order to satisfactorily tropicalize certain instruments being developed by the Technical Staff of the Engineer Board, it is necessary to eliminate all possible points of entrance of fungi and mites. It is believed that this can be accomplished by making such optical instruments fixed-focus.
>
> Before a definite design is established, it will be necessary to ascertain certain facts. These include, but are not limited to, the following:
>
> a. Frequency curves showing the range and distribution of the normal diopter setting for military personnel.
> b. Are adjustable eyepieces necessary?
> c. What value of fixed focus will be most satisfactory, and what percentage of military personnel will be able to use such equipment?

The following statement was prepared by the Secretary on the basis of available information:

a. There are no extensive data on the distribution of refractive errors in service personnel. Dr. W. E. Kappauf, NDRC, has supplied data on 28 Navy enlisted men whose vision tested 20/20. Only 10% needed a refractive correction for best acuity of more than $\frac{1}{2}$ diopter. Many refraction examinations have been made in examining men (Form 1 and Form Y) in the Navy, but no tabulation of results has been prepared. It is required that all refractive defects be correctable to 20/20 vision, and it is expected that men with such defects will wear spectacles in the performance of visual duties.

It is generally recognized that the focus of optical sighting instruments is adjusted by most people to a small minus diopter setting to secure clearest vision. Two sets of data have been obtained to show the actual distribution of such settings by service personnel.

Dr. Leonard C. Mead, NDRC Project SOS-6, has prepared the following summary of the distribution of diopter adjustments for the Mark II Navy Stereoscopic Trainer. The data were obtained during the course of three separate experiments in which this instrument was used. Subjects were instructed to focus the reticle for each eye separately, starting from a setting of +4.0 D.

Experiment	Number subjects	Number settings	Left eye Mean	Left eye S. D.*	Right eye Mean	Right eye S. D.*
I	72	3	-1.3	.85	-1.2	.92
II	19	20	-1.7	1.30	-1.8	1.39
III	82	10	-1.1	.96	-1.2	.94

*Standard deviation

Dr. W. E. Kappauf has analyzed data obtained by NDRC Project N-111 on 28 height finder operators at Fort Monroe. All men were selected at their original training stations for 20/20 vision.

PERCENTAGES OF OPERATORS USING
DIOPTER SETTINGS INDICATED

	DIOPTER SCALE												
	+1	+½	0	-½	-1	-1½	-2	-2½	-3	-3½	-4	-4½	-5
FOCUS													
Binocular	0	21	43	11	17	8	0						
Right eye			0	10	18	14	19	7	11	7	7	0	7
Left eye		0	7	14	15	25	10	8	7	3	4	7	0
REFRACTIVE CORRECTION													
Right eye	0	14	72	7	3	.4	0						
Left eye	0	25	54	10	11	0							

From these distributions it is clear that there is tremendous variability in the actual focus adjustments made by the operators. The settings are quite out of line with the refractive corrections which would be required for best acuity.

b. Several comparisons of the effectiveness of seeing with fixed-focus and variable-focus binoculars have been carried out. All point to the lack of any necessity for variable focus.

(1) A/Cdr. Livingston has reported (Minutes of the Twenty-fifth Meeting of the Vision Committee, FPRC, 30 September 1943) that tests were carried out on three members of aircrew. Little difference was noticed between the value of fixed-focus and adjustable-focus binoculars in daylight, but adjustable-focus binoculars were preferred in low illumination. Further tests were projected.

(2) Systematic and extensive tests have been reported by the Medical Research Laboratory, U. S. Submarine Base, New London (July 23, 1943). Ninety-seven experienced and inexperienced men were used on an outdoor range of 2310 yards. Their acuity with fixed-focus (-0.75 D) 7 x 50 binoculars was compared with adjustable-focus instruments of the same design. No significant differences were found between the performance of men using the two types of instrument under similar conditions. This conclusion was true not only of men whose focus approximated that of the rigid binocular, but also of those whose focal adjustments were divergent from that of the binocular.

(3) No relationship was found between eyepiece diopter settings and accuracy of stereo range settings in a study reported by Arthur Hoffman (NDRC Project SOS-6, OSRD report No. 1729). Eighty-two trainees at the Advanced Fire-Control School, Washington, were subjects on the Mark II Navy Trainer for rangefinding.

The results of these studies indicate no clear advantage of adjustable-focus over fixed-focus instruments.

c. The eyepiece setting for fixed-focus instruments is usually between -0.5 and -1.5 diopters. In response to request, Lt. Comdr. Ballard has stated present Navy practice as follows:

> Fixed-focus ordnance optical instruments have had wide use in the Fleet. Since complaints on this feature have not been received, it can be assumed that fixed-focus instruments are tolerated by Naval personnel. The following fixed-focus telescopes have been in use for many years: Unit-power Aircraft Telescope Sights Mark 3 and Mark 5, with the diopter setting close to 0; the 2.2X telescope of Bombsight Mark 15, with the diopter setting between -1.00 and -1.50 D; the 4X Telescopes Marks 77 and 79, and the 6X Telescope Mark 74, all with settings of -0.75 D. New instruments which are designed to have a fixed-focus setting of the eyepiece include the 7X Telescope Mark 90 and the 6X Telescope Mark 91, both having a diopter setting of -0.75 ± 0.25 D. The latter instruments are 50mm. aperture pressure-proof binoculars. Limited observations indicate best focus settings from Fleet measurements of -0.5 to -0.7 D, but the settings varied from +2 to -2.5!

Experimental comparison of different values of fixed focus has been reported by the Admiralty Research Laboratory (ARL/N4/0502, August 11, 1943). The best focus at both starlight and moonlight illuminations, on the basis of maximum detecting range, of 7 x 50 binoculars was determined for 11 observers to be -1D. This focus gave ranges 10% better than 0 diopters focus. On the basis of these results the Vision Committee, FPRC, recommended -1D focus for night binoculars for all observers whose refractive errors are in the range of +2 to -1D.

d. It might be considered that the focus of -1D is the result of an involuntary accommodation and might give rise to eyestrain over long periods of use. Lt. Sulzman (MC) USNR, was asked to formulate this argument:

> It is axiomatic that persons who are permitted to select their own eye glasses generally choose minus (near-sighted) lenses. The effect of low-power minus lenses upon the youthful eye is to cause objects to appear with greater clarity. This sensation, which is agreeable at first, is caused by the accommodative effort so induced. However, this increase in accommodative effort, caused by the average far-sighted person wearing near-sighted glasses, results in increased accommodative fatigue over a period of time. Older persons are less likely to tolerate such a demand upon waning accommodation and will be aware of ocular fatigue sooner if such a demand is made.
>
> The first effect of incorporating minus power into fixed-focus binoculars is to cause the average younger person to decide that such instruments yield clearer vision. Individuals with a near-sighted error are benefited genuinely. Far-sighted individuals and those with no error of refraction must accommodate when using such instruments. The inevitable result is that fatigue will occur sooner and to a greater degree than if the minus power were absent. Presbyopic individuals may be unable to use these binoculars, depending upon age and refractive error.

An attempt to meet this argument was made in the ARL report referred to above. Three observers, whose accommodation was paralyzed by atropine made the following settings:

Observer	Day Focus	Night Focus
No. 4 (hypermetropic)	+2.25D	+0.5D
No. 10 (hypermetropic)	+1.5	-0.25
No. 11 (emmetropic)	+0.25	-0.5

These data indicate that the negative correction at low illuminations is not the result of an extra involuntary accommodation

Further studies involving performance tests extending over $1\frac{1}{2}$ hours showed that no deterioration or eyestrain results from the use at night of a focus of -1D even in the case of the most hypermetropic observers.

Discussion:

Lt. Dyson called attention to the fact that in trying out rigid binoculars, men have more difficulty with the fixed IPD than with the fixed focus. He suggested that a new binocular design for night work should include a hinge to make possible IPD adjustment, an addition that would cost little more. Others agreed that employing fixed focus and variable IPD is a good compromise solution for making binoculars proof against fungi.

Dr. Tousey asked whether the required focus should be the same for day and night use. The lack of bright detail in ordinary night usage may provide different requirements from those for daytime use. He stated that observers focussing on a star did not make the same minus diopter settings that they did in focussing on an extended area of low illumination.

4. TINTED GLASS IN CONTROL TOWERS

The Bureau of Aeronautics requested the advice of the Committee on the use of tinted glass in control towers. Dr. Hulburt, explaining the request, stated that control tower rooms, fitted with clear plate glass, are reported to be too hot and to have too much glare. The Pittsburgh Plate Glass Co. has proposed a bluish-green heat-absorbing glass for use in control towers; the question is what effect this would have on heat or on glare.

Discussion:

Lt. Comdr. Peckham pointed out that any color in control tower glass will reduce night vision as it reduces total visible light. The best solution is to combine the use of sunglasses with clear glass control tower panels, and to employ air coolers to relieve the heat. Tinted glass does not absorb enough heat for the purpose, at best.

Dr. Hecht felt that the ghastly appearance of people, resulting from the use of the blue-green glass, would be enough to rule out its use.

Lt. Chapanis said that the AAF has issued a sunglass (G-1) especially for control operators. He added that the AAF has a similar problem with aircraft canopies. The use of clear plastic canopies and sunglasses has proved more effective than the use of tinted canopies.

5. CORRECTIVE RETRAINING OF COLOR BLINDNESS

Captain Korb asked the Committee to consider the Dvorine method of corrective retraining of color blind individuals. He suggested that some disinterested group might attempt to validate the claim that this method can train color blind individuals to be able to pass service color vision tests and possibly cure color blindness.

Discussion:

Members, citing individual cases and research studies, agreed that any pseudisochromatic plates used in color vision testing can be learned, and that the use of better instruments for selection tests would do away with the possibility of learning the tests through book methods.

Dr. Hecht suggested that no validational study be proposed since it is a fact that color blindness is hereditary. He pointed out that the American Medical Association has a Council on Physical Therapy, established to evaluate cures.

Captain Korb asked if the Vision Committee would be willing to request the A. M. A. Council on Physical Therapy to consider the Dvorine method as a cure. The Committee agreed, and the secretary was instructed to communicate with the Council.

6. THE INFLUENCE OF SUNLIGHT ON NIGHT VISION

The following preliminary report of BUMED Project No. X-442(Av-233-w) was prepared and presented by Dr. Selig Hecht.

1. Problem

Reports from tropical areas have suggested that twilight vision and night vision show deterioration after exposure to bright sunlight. This raises three problems. Is dark adaptation delayed after exposures to bright sunlight? How long does it take to recover normal night vision? Is the effect cumulative?

Previous researches have shown that the onset and speed of dark adaptation are influenced by the brightness of the preceding light adaptation. The delay of onset may be as much as 15 minutes following very high brightnesses. However, this aspect is probably unimportant in military work since one is rarely required to become dark adapted immediately after exposure to intense sunlight.

Previous measurements have also shown that the achievement of the final threshold of night vision may be delayed out of all proportion to the delay of the onset of rod adaptation.

2. Measurements

To study this delay as well as the cumulative effect, a project was set up at the Medical Field Research Laboratory at Camp Lejeune, North Carolina, with the cooperation and help of its director, Commander W. N. New, and its executive officer, Lieutenant Commander Skinner.

All measurements were made with the Hecht-Shlaer Adaptometer Model 3. This determines the night vision threshold by means of a 3° circle viewed binocularly 7° below a red fixation point, using exposures of 1/5 second.

3. Temporary Effects of Sunlight

The first series of experiments involved 6 groups of subjects totalling 43 individuals. These subjects had their night vision thresholds measured in the morning after an hour of dark adaptation. They were then exposed to sunlight on the beach. The sky brightness varied between 3000 and 5000 foot lamberts, the water between 1000 and 3000 foot lamberts, and the sand between 1000 and 2000 foot lamberts. The exposures to sunlight varied between 2 and 5 hours. The subjects returned to the laboratory, and their thresholds were

again measured at various times after their return. The thresholds after 3/4 to 1 hour of dark adaptation showed a uniform rise of between 0.12 and 0.27 log units with an average of 0.22 log units. The threshold rise persisted for several hours, and 5 hours after arrival it was still 0.15 above the previous level. Recovery was nearly complete the next morning though an average slight rise persisted. These experiments were repeated more systematically later on 9 occasions with 20 subjects, and similar results were obtained.

It is therefore evident that bright sunlight not only delays the onset of rod dark adaptation, but for several hours subsequent to the exposure the final night vision threshold, even after an hour adaptation, is still above its pre-exposure level.

4. Cumulative Effects of Sunlight

For the study of the cumulative effect of sunlight we arranged two groups, one of 30 individuals for sunlight, and one of 25 for controls. The groups were so chosen that their threshold distributions were almost identical. The control group was given indoor tasks, instructed to avoid sunlight, and supplied with dark adaptor goggles to put on out of doors. The sunlight group was exposed between 3 and 6 hours daily to sunlight. Both groups had their night vision thresholds measured after dark adaptation morning, late afternoon, evening, and next morning.

If there is any cumulative effect of sunlight, it should become evident from a comparison of the morning readings only. Such a comparison shows that after 2 days of exposure, the one hour threshold of the sunlight group began to rise above that of the control group; by 10 days it was nearly 0.25 log unit higher than the controls; after 15 days the difference between the two groups decreased, and settled down to 0.11 log units.

After 25 days, the two groups were reversed, in that the control group was put in the sun and the sunlight group was kept indoors. After 2 days, the morning one hour thresholds reversed their direction. The threshold of the old sunlight (now indoor) group steadily decreased while the old control group's (now sunlight) threshold rose. The two thresholds became the same 5 days after the change. Moreover, they continued to separate, and at the end of a week, the control (now sunlight) group threshold was 0.10 log unit above its previous level, while the indoor (old sunlight) group had returned almost to normal.

It is apparent that the cumulative effect of sunlight, though not spectacular, is real. However, the sunlight was not extreme, since Camp Lejeune is 34 $\frac{1}{2}$° N. Lat., and the experiment occurred during September and October. Moreover, the exposures were

5. Meaning for Night Visual Functions

These cumulative effects, when applied to visual performance, represent a real loss in visual capacity such as in the frequency of seeing, in visual acuity, in range of vision, and in brightness discrimination. In all these cases a rise of 0.2 log unit in night vision threshold means a loss of between 30 and 50 per cent in visual function as compared to the normal. Thus if the frequency of seeing a target is 9 times out of 10 for a normal performance, then a rise of 0.2 log unit will reduce this frequency to 5 and sometimes to 4 times out of 10. Visual acuity and visual range will similarly be decreased by about 40 per cent in comparison to normal; and a contrast in order to become visible would have to be increased by a similar amount.

6. Recommendations

Two recommendations follow from these measurements. The first is that since these effects become apparent at ordinary sunlight, it is desirable that they be studied at brighter sunlights such as occur in the tropics in the summer. Moreover, since these effects show on night vision, it is desirable to study them as well on twilight vision involving cone function at its lowest values.

The second recommendation is that proper sunglasses be provided to those individuals who, while continuously exposed to sunlight, are also expected to perform night duties. These sunglasses should transmit about 10 per cent of light, though it would be better in intense sunlight that they transmit no more than 5 per cent of the light.

Discussion:

Lt. Verplanck, commenting that many lookouts have four hour day duty and four hour night duty, asked if the dense glasses suggested by Dr. Hecht would reduce the daylight acuity too much. Dr. Hecht thought not since the visual acuity curve is flat above 100 foot lamberts.

Dr. Blum asked whether the effect of intense sunlight, being chronic and cumulative, might possibly be ascribed to ultraviolet radiation. Dr. Hecht stated that present information did not permit an answer to the question, but that protection against bright light would automatically take care of any ultraviolet effect.

Lt. Nolan called attention to a British study of dark adaptation in Egypt which recorded a threshold difference of the same order as that reported in the present study. Dr. Hecht

explained that a slight rise in threshold was reported; the Admiralty Research Laboratory discounted it, however, and on the basis of one experiment in London (ARL/N1/84.11/0) concluded that the effect is negligible. The moderate intensity of sunlight at the latitude of London renders this negative result of limited significance.

Dr. Tousey asked about changes in pupil aperture as the result of prolonged exposure. Lt. Comdr. Peckham stated that the changes in threshold reported by Dr. Hecht might conceivably be due either to change in retinal sensitivity or to a reduction in the amount of light reaching the retina, resulting from decreased pupil aperture, corneal opacity, or some other factor. If the effect is due to decreased light transmission, the transmission would have to be reduced by 50%, and the changes in pupil size would have to be very great in order to produce the reported change in threshold. The more reasonable assumption is that the effect is retinal (chronic desensitivity). If this assumption is correct, the effect would be debilitating in day as well as night vision.

Dr. Hecht said that previous experiments were made with fixed pupil size; consequently change in pupil aperture is ruled out as the factor. He agreed that the sensitivity of day vision is a problem; no analysis of daylight acuity has yet been made. If the study is continued under brighter illuminations, daytime measurements will be made and the results reported.

The Committee voted unanimously to recommend that Dr. Hecht's work be continued and that measurements be made in the tropics to determine the light level and the effect of exposure to tropical light on day and night vision.

There was considerable discussion of the second recommendation proposed by Dr. Hecht. Lt. Verplanck suggested that the recommendation specify low transmission filters for all optical instruments used during the day by men expected to perform night duties.

Lt. Nolan objected to the low transmission figure suggested. He felt that men would not wear goggles of such density and that fifteen per cent transmission would give adequate protection.

Lt. Comdr. Peckham pointed out that the Navy is distributing the 15% transmission, neutral sunglass in very large quantities. He thought that the Committee would be more realistic if it were to recommend that these sunglasses be used in conditions of sunlight. When further work is done, the proper density could be determined by trying sunglasses of several densities.

Several members were concerned about the implementation of this recommendation. Captain Shilling and Lt. Nolan thought the

order should be limited to those standing night lookout. Comdr. New said that unless the recommendation was designed solely for the Navy, it would have to be broader. Men in the Army and the Marines are subject to call, without previous notice, for night missions.

Dr. Hulburt thought it was unwise to make a recommendation for sunglasses of 5% transmission on the basis of one study. Lt. Comdr. Peckham told of asking 50 men to wear glasses with transmission of 1, 4, and 10 per cent and to express their preferences. The sunglass of 4 per cent density was preferred by about 65 per cent. The Navy 15% transmission sunglass was recommended as a compromise because most men have not had sufficient experience with sunglasses to accept the greater density.

The secretary reworded the second recommendation, and the Committee voted unanimously to recommend that personnel required to perform visual duties at night after prolonged exposure to sunlight use, during daytime exposure, sunglasses or filters for optical instruments with transmissions of not more than 15%.

Dr. Blum asked that Dr. Hecht incorporate a test of the ultraviolet factor in further work.

7. ULTRAVIOLET RADIATION AT HIGH ALTITUDES

The following reports were prepared in response to a request from AAF (Minutes, fourth meeting, p. 6, item 4).

A. Biological Effects of Ultraviolet Radiation on the Eye at High Altitudes

Dr. Harold F. Blum

All evidence indicates that the principal, and probably the only important, primary effect of ultraviolet radiation on the eye is injury to the cells of the cornea and conjunctiva by wavelengths shorter than about 3200 A. The immediate gross effect of this injury is conjunctivitis, accompanied by photophobia. If the damage is severe enough, the conjunctivitis may be disabling, as in snow blindness. The effects of mild conjunctivitis on vision, or the changes resulting from chronic exposure, are matters of conjecture at present. There is little evidence that deeper structures in the eye are affected or that the longer wavelengths of the ultraviolet are injurious.

There is not enough quantitative information on the effects of ultraviolet radiation to permit an accurate estimate of the amount of injury that will occur with a given intensity of sunlight. For this purpose, measurements of the amount of ultraviolet radiant energy required to produce conjunctivitis are necessary for a number of wavelengths. While we may safely predict that the spectral sensitivity curve will be similar to the erythema spectrum for sunburn of the skin, or to the action spectra for killing curves for bacteria or other unicellular organisms, which generally resemble the absorption spectra of either proteins or nucleic acid, close agreement is not necessarily to be expected. Hence, any estimate based on such curves is apt to lead to erroneous conclusions about the amount of injury to be expected from sunlight.

There is some variation in findings with regard to the intensity of ultraviolet radiation of wavelengths shorter than 3200 A in sunlight at high altitudes. The very careful measurements made by Dr. O'Brien, in connection with the stratosphere flight of the Explorer II, indicate that such radiation will be approximately the same at all heights up to about 50,000 ft. The measurements of Dr. Coblenz, which were made with a less satisfactory method and, hence, are more open to question, show a marked increase in ultraviolet radiation at lower altitudes; these measurements suggest an increase of about 2 to 4 fold between sea level and 30,000 ft.

There seems no basis for a categorical statement regarding the importance of ultraviolet radiation at high altitudes, but the removal of the part of the radiation that injures the eye is not difficult since it is cut out by window glass or appropriately treated plastics. It would seem wise to guard against any eventuality by using such materials where there is danger of exposure to sunlight at high altitudes.

B. Protection Against Ultraviolet in Plastic Enclosures at High Altitudes

Lt. Comdr. R. H. Peckham

The problem of protection against ultraviolet solar radiation at high altitudes is a very definite and real one, even though such protection is somewhat less essential at sea-level in moderate latitudes.

Attempts to measure ultraviolet radiation with sounding balloons and passenger-bearing stratosphere balloons indicate that the absorption of the ultraviolet is principally accomplished by the ozone content of the atmosphere and that the solar radiation in ultraviolet increases with altitude by a factor probably as great as four times. The effect of this increase of ultraviolet radiation has been to increase the incidence of sunburn, especially of the nose and hands, in personnel flying at even moderate altitudes.

Two possible solutions to this problem have been found, however. A special yellowish dye, called XY91VO, has been developed by the Polaroid Corporation. This dye tranmits 91% of visible light and less than 1/100 of 1% from 395 millimicrons to 200 millimicrons. This dye can be introduced into plastic aircraft windows or into the plastic bonding sheet in shatterproof glass windows. A concentration of dye sufficient to accomplish the necessary absorption can be introduced into a cellulose acetate sheet 0.003 inches thick without precipitation.

A second and even more attractive solution would be the use of a plastic which, by its inherent characteristics, absorbs radiation in the erythemal band. Such a plastic is the Monsanto 20552 TPA, which, at 0.200 inches thickness tranmits less than 0.01% from 200 to 350 millimicrons. Because of either the plasticizing agent or the stabilizing agent this material is opaque to erythemal ultraviolet, and it is as transparent as clear glass. It is further understood that this material has been rated as acceptable from a mechanical standpoint for Naval Aircraft procurement.

Discussion:

Dr. Blum and Lt. Comdr. Peckham agreed in their recommendations to the Army Air Forces: Plastic is available that will cut out ultraviolet light without reducing visible light. This would give adequate protection up to 50,000 feet. Glasses and sunburn ointment would probably be adequate if this plastic were not used.

Lt. Chapanis wished to know whether the danger from ultraviolet is great enough for the AAF to specify one of the ultraviolet opaque materials and change 2,000,000 airplane windows. Dr. Blum said that in his opinion it should be done.

Lt. Comdr. Peckham called attention to the fact that some of the plastic in present use does not transmit ultraviolet. Some means of measuring each window would make changing all windows unnecessary. The cost of changing the windows will be investigated by Lt. London and Lt. Chapanis.

Dr. Hulburt asked whether the Spectrogeograph could be used to secure data on the intensity of ultraviolet radiation of wavelengths shorter than 3200 A in sunlight at high altitudes. Dr. Duntley indicated that it could be done.

Lt. Nolan suggested the use of an ultraviolet counter for the same purpose. Dr. Blum stated that the Naval Medical Research Institute has photocells, which could be used if advisable, but that Dr. O'Brien does not think the data would be of value since no one knows whether the spectral sensitivity of the photocell simulates that of the eye.

Lt. Comdr. Burroughs suggested that the Committee invite Dr. O'Brien to give a paper on the distribution of ultraviolet.

8. SPECIFICATIONS FOR A HEAT-FILTER LENS IN THE VARIABLE-DENSITY GOGGLE

In response to a request from QMG, the Committee asked Lt. Comdr. Peckham to prepare the following report on the Variable-Density Goggle.

The Variable-Density Goggle is a device procured by both Army and Navy, containing rotatable polarizing lenses, which permit the wearer to control their density from about 20% transmission when the filters are open to about 0.1% transmission when the filters are closed or crossed. This device was issued to anti-aircraft lookouts for use in scanning the area near the sun.

The device has been used for nearly two years without authenticated reports of retinal damage. However, interviews with personnel who use the device indicate that it may be used as a sun shade by tipping the head so that the edge of the goggle aperture obscures the sun's disc.

A recently proposed change in the design of this goggle has increased the visual field by enlarging the lenses and mounting them at an obtuse angle. This increases the field considerably but reduces the convenience of using the device as a sun shade. Hence, we can expect ocular fixation on the solar disc for long periods, and, therefore, the effective transmission of the filters with respect to the solar radiation must be examined critically.

Computation of solar radiation, air mass zero, through the goggle shows that 22% of incident solar radiation is transmitted by the device in the closed position. At the same time, the visual image of the solar disc is reduced to less than 1/10 of 1% of its unprotected brightness. The reason for this difference lies in the failure of the polarizing element effectively to polarize light of wavelengths longer than 800 millimicrons. Since the ocular media absorb much of this near infrared radiation, the effective intensity of the solar image on the retina would be about 4%.

Blum has shown that damaging intensity at the retina can be estimated at about 10% total energy intensity. It follows that the device in its previous form is fairly close to the maximum tolerable transmission and that it does not allow a comfortable margin of safety.

Since the new form of the device will require more frequent fixation of the solar disc by virtue of its increased visual field, and since the estimate made by Blum is conservative, but not experimentally established, it would be advantageous to increase the absorption of this device for radiation above 800 millimicrons. Such additional protection

could be accomplished conveniently by placing a heat-absorbing filter in place of the present clear-glass dust cover embodied in the new design. This heat filter must have high visual transmission and may not interfere with the dichroic red-purple tracer fire filter that is attached to the front of the goggle.

Only one such glass is at present obtainable. The spectral characteristics have been determined for the range of solar radiation. The computation of the combination shows that, relative to solar energy with air mass zero, the transmission of the device in the closed position will be about 1/10 of 1% visual brightness, 2.7% total solar energy, and 0.3% solar intensity at the retina, when the thickness of the glass heat filter is 2mm.

This glass is limited in quality. It will be liable to small bubbles, but careful selection of lenses can overcome this defect. The glass cannot be conveniently prepared in thicknesses less than 1.8mm. At present, this glass is the only one available which will yield the required protection.

It is therefore recommended that the specific heat resisting glass, known as AO43 (American Optical Company), not less than 1.8mm. thick, be used in place of the present dust-protective cover in the new design of the Variable-Density Goggle.

It will be of interest to note, in passing, that adequate protection against ultraviolet radiation is accomplished in both the present and the proposed designs by the polarizing elements.

9. SHIPBOARD STUDY OF PERFORMANCE OF NIGHT LOOKOUTS

The following report of the results of NDRC Project N-115 was presented by Dr. W. C. H. Prentice.

The data reported here were gathered during the course of a convoy cruise in the North Atlantic by two members of NDRC Project N-115.

The procedure used was to have one experimenter measure the brightness of the night sky and sea, while the second asked each lookout in turn to give the bearing of the farthest ship he could see. The range of that ship was then obtained from the radar operator. The raw data, then, were simply ranges and bearings of ships whose sizes could be obtained from a chart of the convoy. In order, however, to make the different sightings quantitatively comparable, it was necessary to make a large number of corrections in each value. It was necessary, for instance, to correct the size of the ship for range and to correct the size of the visual target thus determined for the amount of light available. It was also necessary to correct for the angle at which the ship was sighted, for the height of the lookout, and for the brightness of the sea where the entire ship was not silhouetted against the sky.

The result of all these calculations was a figure which we have called equivalent square feet, abbreviated ESF, which is the size of a hypothetical target seen at 1,000 yards in rather bright moonlight (.05 foot lamberts), and visually equivalent to the real target.

The scores for 114 men averaged 219 ESF. Since this score was somewhat raised by a few extremely high scores, it seems reasonable to accept a round figure of 200 ESF as typical of the average performance of lookouts on the ship studied. This figure of 200 ESF means that the typical lookout, using 7 x 50 binoculars, could see a target of 200 square feet at 1,000 yards in bright moonlight. At 5,000 yards, the target would need to be 5,000 square feet in area. At 10,000 yards, he requires a target of 20,000 square feet, or about the size of a large cargo ship seen broadside. On a moonless, clear night, the same man could see the identical cargo ship not farther than 5,000 yards. On a moonless, overcast night, this average man's effectiveness is almost entirely lost beyond 5,000 yards even for the very largest ships. Actually, he should be able to see a target of 40,000 square feet at 5,000 yards.

The very poorest men can be judged in terms of the poorest score obtained from a man who was tested on five different occasions, and whose average score was 1360 ESF, meaning that he requires a tar-

get at 1,000 yards in bright moonlight to be 1,360 square feet in area before he can see it with 7 x 50 binoculars. At 5,000 yards in bright moonlight, this man requires a target of 34,000 square feet, which is about the size of a large transport ship seen broadside. On a moonless, clear night, no modern ship is large enough for him to see at 5,000 yards. On a moonless, overcast night, even at 2,000 yards, a target must be 43,500 square feet in area for him to see it. This is about as large as the largest passenger vessels.

The range between the best and the poorest men is exceedingly large. The best of our subjects, chosen on the basis of five scores, averaged 40 ESF, meaning that he could see a target of 40 square feet in bright moonlight at 1,000 yards, using 7 x 50 binoculars, or a target about 1/34th as large as that required by the poorest man. The man chosen to typify this high-grade performance could see a ship of 32,000 square feet in area (large transport) at 10,000 yards even on a moonless, overcast night. At the same distance he could probably see a destroyer on a starlit night and a ship about the size of a PC on a moonlit night. Given the same ship and the same lighting conditions, he can spot the target almost six times as far as the poorest man.

The consistency of night lookouts is a problem of very great interest. In this study we were able, unfortunately, to test only 30 men on four or more occasions. The Pearsonian coefficient of correlation between the odd and even scores for these 30 men is +.658, a surprisingly high coefficient in view of the rather large range (as measured in ESF) between each man's best score and his worst score. For practical purposes, this measure of the actual range between a man's two most extreme scores is a better measure than the correlation coefficient. Obviously, the Lookout Officer will want to know, for instance, what kinds of target a man might see on one night and miss on another. The average difference between the extreme scores for 92 men who were tested on two or more occasions is 331 ESF. Interpreting this difference roughly, the Lookout Officer may assume that a man might vary from very poor performance to average; but it is extremely unlikely that any man will vary over more than half of the total distribution. On the other hand, a man who is very good on one occasion should remain better than average.

Aside from practical considerations, it is of interest that the system of measurement used is apparently highly reliable, and also that the performance itself is apparently an accurately measurable biological function. This is shown by the fact that when the ESF scores are translated into log units, the correlation coefficient for the same 30 men goes up to +.87.

Finally, the investigators tried to discover what relationship, if any, the obtained measure of efficiency of night lookout

performance might have with test scores obtained on the Radium Plaque Adaptometer. Since the Radium Plaque was not designed for making this sort of prediction, and its scores are, consequently, difficult to correlate with other measurements, it is hard to arrive at any final conclusions. Nevertheless, two sorts of information are available. 1) Of 63 men tested on the Radium Plaque, 50 passed and 13 failed. The average ESF score for these two groups is nearly identical. The fact that the difference between the two averages is insignificant is attested by a critical ratio of 0.18. 2) A group of men having the very best ESF scores and a group having the worst ESF scores have been compared with respect to their classification on the Radium Plaque test. The 12 poorest night lookouts were chosen because they appeared to form a group of extremely bad lookouts, rather well separated from the main body of the total distribution, and they were compared with the 12 best lookouts. Of the 12 best men, 8 passed the Radium Plaque and one failed. We have no records on the other 3. Of the 12 poorest men, 7 passed the Radium Plaque, one failed, and we have no records on the other 4. The critical ratio of the difference in ESF score between these two groups, incidentally, is 8.41. In other words, these two groups have a highly significant difference in their score on night lookout performance, but are apparently undifferentiated with respect to Radium Plaque performance. There are many possible interpretations of these data. The one striking fact is that at least one man who had failed the Radium Plaque test was able, nevertheless, to average 53 ESF on six trials, or, in other words, to be one of the best lookouts tested.

Discussion:

Lt. Comdr. Burroughs asked how the brightness level of the ESF test compared with the brightness level of the Radium Plaque test. Dr. Prentice said that the ESF brightness level is high. He agreed that the Radium Plaque test is not a test of lookout ability, but of what the subject can see at a given level of illumination. The difference in level of illumination between the two tests might account for the low correlation. Dr. Hartline cautioned against using Radium Plaque test results unless each subject has been tested several times.

Lt. Comdr. Dyke asked if any provision had been made for the fact that the distribution of ships in the formation might be such that the ship sighted by one man would be at the midpoint of his maximum range, while that sighted by another, although more distant actually, would be just within his maximum range. Dr. Prentice replied that they had no way of determining how far a lookout could see except to record the farthest ship sighted and to assume that the differences resulting from ship distribution would be cancelled out by the number of trials.

Dr. Marquis inquired about the effect of atmospheric transmission, suggesting that this might account for the variability in the data. Dr. Prentice explained that data for clear nights were compared with those for hazy nights and that no difference could be detected. Dr. Duntley has agreed to compare the data with his experimental data on atmospheric transmission.

Dr. Prentice raised the question of means of measuring haze. Dr. Hulburt said that a hazemeter could be put on ships if the appropriate equipment and personnel were made available. S/Ldr. Goldie mentioned the use of a nephelometer, and Dr. Duntley suggested that a transmissometer could be used for measurements from ship to ship.

10. A SHIPBOARD NIGHT VISION TRAINER

Dr. Carl Wedell demonstrated the trainer and prepared the following description.

The shipboard night vision trainer is designed to provide a portable unit which meets the practical requirements of space and other limitations found on board ship. It is constructed in two models. Model A is for use with groups of four to approximately sixteen men where a large darkroom is available. Model B, described here, is for use with one or two men in a dimly lighted room.

1. Description - Model B is Model A adapted for use in a darkened, but not completely light-proof, room. The plaque-holder is housed in the back of an almost light-tight box (9-5/8" x 12-7/8" x 6- 1/8"). Near the front end of the box, a plastic binocular viewer, cut to fit the facial contour, is mounted on a pivot so that the distance from the eye to the plaque is maintained at 10". Cut-outs at the front of the box accommodate the head. A heavy cloth covers the space between the sides of the box and the viewer, permitting lateral movements of the viewer across the 66 degree field. The test plaques are inserted through a curved slot in the top of the box. To protect the luminous plaque from direct light when not in use, a black opaque shield fits into the test plaque slot.

The space between the viewer and the holder, available through a side, light-tight door, provides storage space for accessories -- red goggles, test plaques, binoculars test, red flashlight, pencils, pads, and directions.

2. Use - Like Model A, this trainer is designed for individual observations, but it can be used in a partially darkened room. Red goggles must be worn during the period of dark adaptation and at all times when not actually viewing in Model B. In shifting from the goggles to the trainer the eyes are tightly closed, the goggles are next pushed back on the forehead, then the front cover and cut-outs are quickly removed from the trainer, and the head placed in proper position. In this position the eyes are opened.

In use, the accessory material is removed through the side door under dim light; the test plaques arranged in order; and the trainer supported on the trainee's knees. Under the darkest condition possible the black shield is removed from the slot and replaced by the first test plaque. After use, the shield is inserted to protect the luminous plaque from light.

3. Test Plaques - Eight test plaques have been devised. Both object-detection and form-perception are tested by these plaques.

Plaque 1 - A scene composed of common objects, for demonstrating progressive increase in visual acuity during dark adaptation.

Plaque 2 - Three sizes of Landolt rings, each within two concentric circles, for training in off-center vision, and assisting the trainee to find his optimal off-center fixation point.

Plaque 3 - Three rows of Landolt rings, each row of a different size, with the openings in different positions. This plaque can be used either as a training device or as a test.

Plaque 4 - Similar to plaque 3 except for the smaller size of Landolt rings.

Plaque 5 - Nine different combinations of two dice each -- the spots vary in size, but all spots on any one die are the same size. This plaque can be used to stimulate individual competition.

Plaque 6 - Similar to plaque 5, except that spots on any one die vary in size.

Plaque 7 - Three rows of small ship silhouettes. This plaque can be used for object detection by indicating ship bearings, and also for recognition.

Plaque 8 - Three rows of larger ship silhouettes, for recognition training.

4. A rough drawing showing the Model B trainer as it would be constructed of steel is shown on the following page.

Discussion:

Lt. Comdr. Peckham commented that since the radium plaque would be activated by exposure to light, it would be impossible to keep the level of illumination constant for testing purposes, and, eventually, the instrument would break down as a trainer. Dr. Wedell pointed out that this had not happened during the trial of the trainer.

In order to find out if the Navy has need for such a device, members suggested that the instrument and a cost estimate (approximately $35.00) be submitted to Training Aids Division, Bureau of Naval Personnel, for review.

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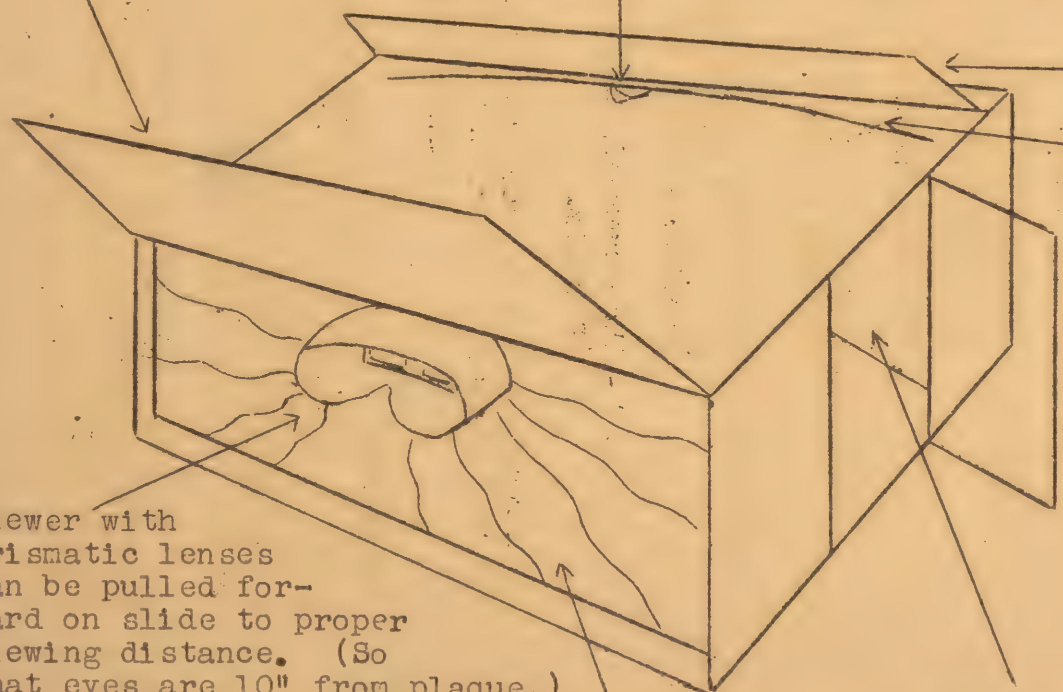
NDRC Project N-115

ROUGH DRAWING SHOWING CONSTRUCTION OF SHIPBOARD
NIGHT LOOKOUT TRAINER

Approximate size: width 12-7/8"; length (front to back) 9-5/8"; height 6-1/8".

To be made of 22 gauge, "bonderized" or zinc-chromated steel. Coated dull black inside, and Navy grey or black outside.

Estimated cost per 1000, $35.00 each.



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was a tendency toward shorter scanning periods, and lower percentages of time spent in scanning.

The observer and certain of the ship's officers were timed during what they considered sufficiently careful scanning of a 120° sector. These records indicate that the time required is in the neighborhood of 90 seconds to 2 minutes, i.e., scanning should proceed at a rate of one degree per second.

The individual consistency of the lookouts seems to indicate that proper initial training will result in more uniformly careful search; the wide divergence seems to indicate that, as far as the observable task of scanning is concerned, the one and one-half hour period on the bridge with half-hour shifts of position, is not too long. However, no data are available on visual efficiency through this watch period. Finally, there is some indication that provision of a special stern lookout post might improve performance of the stern lookout.

General observations on practices of lookouts, and of their officers show the need for emphasizing the importance of officer training. It is clear that uninterested and uninformed officers produce poor lookouts regardless of their previous training; but interested and able officers can train lookouts on the job with great effectiveness. Most of the faults of lookouts can be traced to lack of effort on the part of OD's and JOOD's.

Practices with respect to dark adaptation were found to be uniformly good.

A more complete report will be issued in the near future.

Discussion:

Dr. Prentice was concerned about the rate of scanning recommended by Lt. Verplanck. At the rate of two minutes for 120° along the horizon, a sky lookout with a 45° sector would not return to the same point for several minutes, using the standard scanning technique. He suggested that a similar study be done on a carrier in order to determine the best rate of scanning for sky lookouts.

Lt. Verplanck insisted that to scan faster than one degree per second is confusing although there may be ways of making more rapid scanning possible. One difficulty in scanning is the lack of a fixation point on the horizon. If the lookout's binocular were provided with a single vertical hairline in one barrel, the lookout could be trained to move the binocular at the slow rate

necessary and to look at the hairline on the horizon. This might automatically yield a close, neat pattern of search without fixation difficulties.

In reply to W/Cdr. Lee and S/Ldr. Goldie, Lt. Verplanck stated that binoculars were used day and night except during rain and that the binoculars were without effective support.

On the question of the effectiveness of lookout training, Lt. Verplanck said that only a few men had had lookout training and that, in his opinion, it seemed ineffective except as motivation.

Comdr. Butler, formerly Gunnery Officer on the Boise, told the Committee of his experiences in handling the lookout problem. He stressed the importance of incentive to good lookout performance and the responsibility of the OD for encouraging lookouts. Forming a lookout division on shipboard and having lookouts report to the division officer proved successful in building morale. Combining the lookout division with the radar division gave status to the lookout's job. Comdr. Butler cautioned against having too many lookouts because of the resulting tendency for the men to shift responsibility to someone else.

Adding to Comdr. Butler's statement that radar cannot replace the eyes of the lookout, Captain Shilling asked about data comparing radar and lookout effectiveness. Lt. Comdr. Burroughs informed him that the Anti-aircraft Board has data, but they are not worked up.

Several members asked for Comdr. Butler's opinion on lookout motivation. He agreed that a good lookout could not be kept as a lookout indefinitely, but he questioned the incentive value in requiring lookout training for all ratings. He felt that lookout might then be just something for the men to suffer through; a rating for lookouts would be a better solution.

Comdr. Peden, stating that a lookout rating is not justifiable, suggested lookout divisions in which men can get training for jobs that have ratings while performing lookout duties.

12. LOOKOUT TRAINING IN THE NAVY

Copies of the U. S. Navy Standardized curriculum, Lookout-Recognition for Recruits, and the proposed designation, "Expert Battle Lookout," were distributed while Lt. J. C. Snidecor reviewed briefly the various parts of the curriculum, the time in training devoted to each, and the training aids employed.

Discussion:

Members expressed serious concern about the effectiveness of the designation, Expert Battle Lookout, as a means of securing better lookouts. In general the problems raised were: (1) Should a requirement for recognition competency be included? (2) Should performance on duty outweigh test performance? (3) How many men should be expected to become Expert Battle Lookouts? (4) Are the standards too high for this goal?

Several members urged that since a lookout's job is to report everything he sights, not to recognize what he sights, recognition ability is not essential to a lookout and should not be a requirement for Expert Battle Lookout. They cautioned against interfering with the lookout's job of sighting by overemphasizing recognition training. Others agreed but pointed out that recognition training has high motivational value in classroom training as well as in actual use on shipboard. As an example, Comdr. Peden cited the use of recognition training by lookouts in their amplifying reports. Lt. McCarthy stated that the best lookouts are those with recognition training; Captains ask for such men when they need lookouts.

Captain Shilling inquired whether the badge would be given for the lookout's performance on duty or on tests; whether he could be disqualified for inefficient performance of his duties; and whether recognition is one of his duties. Lt. Britt replied that the award would be on the basis of tests and the recommendation of the commanding officer.

Captain Shilling and Lt. Verplanck urged that a reward for lookouts be given for a good conscientious performance on a station, regardless of performance on a test. Lt. Verplanck suggested that the requirements for Expert Battle Lookout be based on a lookout job analysis.

Some members felt that a reward earned by very few men is a good motivational device, and the standards set for Expert Battle Lookout are not too high. The majority of the group believed, however, that it is unreasonable to expect seamen, second class, to be motivated by a complicated set of standards

almost beyond accomplishment. Specific standards cited as too difficult were: (2) QUALIFICATIONS. (B) LOOKOUT THEORY AND PRACTICE. (b) Target Location - Possess a thorough knowledge and understanding of and demonstrate by performance proficiency in determining quickly and accurately, in reference to a target sighted, the following: (i) Relative bearing, within 10 degrees of actual bearing, (iii) Target angle, within 10 degrees of actual angle; (2) QUALIFICATIONS. (D) RECOGNITION. (b) Score Required - 90% of the ships and 90% of the aircraft shall be correctly recognized; (2) QUALIFICATIONS. (B) LOOKOUT THEORY AND PRACTICE. (c) Reporting and Battle Phone Procedure - Possess a thorough knowledge and understanding of reporting and battle phone procedure and terminology, and demonstrate by actual performance proficiency in reporting properly the data observed and determined when a target is sighted.

Lt. McFadden thought the relative difficulty of the standards would vary from ship to ship and that most lookouts on some ships could get the designation. Lt. Pfister told of teaching 45 planes over a period of 24 hours to men whose previous recognition training ranged from none to 75 hours. Score ranged from 7-238 out of 240, and there were very few over 90%.

Lt. Comdr. Dyke asserted that high standards will not function as incentive if they are too high and that it is unsound to train men for duties they will not be expected to perform. He suggested that the Expert Battle Lookout designation be maintained and that the establishment of a second class qualified lookout rate with achievable standards and no recognition requirement be proposed.

Dr. Marquis suggested that the percentage of men expected to qualify as Expert Battle Lookouts be determined, and, with this as a reference point, that standards be adopted accordingly.

After considering the most effective method for presenting the views of the Committee on the Expert Battle Lookout designation, the Committee agreed that the chairman should forward a digest of the discussion of the proposed Expert Battle Lookout designation to the Bureau of Naval Personnel.

ABSTRACTS

11. AN INVESTIGATION OF MOTION ACUITY UNDER SCOTOPIC CONDITIONS AT VARIOUS RETINAL POSITIONS

Warden, C. J., Committee on Aviation Medicine, Report No. 326, 30 April, 1944, 6pp., (restricted).

In a study to check the Navy Radium Plaque Adaptometer against the Columbia University Motion Test, 100 subjects were tested on both apparatuses at the same level of illumination. The stimulus figure (Snellen "T") subtended an angle of 3 degrees at 5 feet; the fixation point was 7 degrees above the center of the "T". No significant relationship was found between photopic form acuity (Snellen Test) and either scotopic form acuity (Adaptometer) or scotopic motion acuity (Columbia motion apparatus), but a high correlation (.93 ± .01) was found between the two scotopic tests. Both tests were found highly reliable. The split-half reliability coefficient (uncorrected) for the Adaptometer was .82 when 50 trials were obtained. The authors object to the standard short series (10-20 trials) now employed in the Navy, because of unreliability.

12. THE INFLUENCE OF THE VISUAL TASKS REQUIRED OF PERSONNEL IN THE SIXTEEN WEEKS FIRE CONTROLMEN (O) TRAINING COURSE UPON THEIR VISUAL PROFICIENCY

Adams, J. K., Beier, D. C., and Imus, H. A., NDRC, Applied Psychology Panel, Project N-114, Report No. 7, 1 August, 1944, 26pp., (restricted).

Because operators of optical instruments and operators of oscilloscopes in the Army and Navy have in many cases felt that their work has an injurious effect upon visual functions, an investigation was made of the effect of the 16 weeks course for Fire Controlmen (O) upon visual functions. This course, which is given at the Naval Training Schools, Fort Lauderdale, Florida, requires a large number of hours of practice on stereoscopic trainers and rangefinders, on tracking telescopes, and on radar oscilloscopes, in addition to reading for theory courses. At the beginning and again at the end of the 16 weeks course, seventy-seven men (Class VII) were tested for visual acuity (far and near vision), vertical phoria, lateral phoria,

stereopsis, and color vision with the Bausch and Lomb Orth-Rater. An additional measure of stereopsis was obtained with the Multiple Projection Eikonometer (stereo vertical test). It was found that: (1) There is no deterioration of any of the above visual functions as a result of the 16 weeks course. (2) There is a slight improvement in visual acuity scores for right eye and for worse eye. (3) There is an improvement in stereopsis score on both the Eikonometer, stereo vertical, and the Ortho-Rater. (4) There is an improvement in color vision score on the Ortho-Rater. It is recommended that all service personnel who are required to use their eyes in operations similar to those required in the Fire Controlmen (O) course, be indoctrinated with the knowledge that it is much more probable that their visual functions are improving than that they are deteriorating.

13. INVESTIGATION OF COCKPIT ILLUMINATION ON R4D-5 AND R4D-1 AIRPLANES

U. S. Naval Air Station, Patuxent River, Project TED No. PTR-31528.0, 22 August, 1944, 9pp., (restricted).

This report of the installation of cockpit red light and instrument ultraviolet light illumination in the R4D-5 airplane gives a detailed notation of equipment removed and installed and a step-by-step description of the installation, considered satisfactory for use in this type of Naval aircraft.

14. REPORT COVERING INVESTIGATION OF COMBINING THE NIGHT LOOKOUT TRAINER AND THE EVELYN NIGHT VISION TRAINER INTO ONE UNIT

U. S. Submarine Base, New London, NB 7/P11-1 (MR), No. 3498, 29 August, 1944, 4pp., (not classified).

Experimental findings indicate that it is not possible to combine the desirable features of the BuPers night lookout trainer and the RCAF (Evelyn) night vision trainer because the two devices are fundamentally different in design, construction, and purpose. Many expensive and complicated changes in the BuPers trainer would be necessary, and these changes would destroy the desirable features of each.

15. THE EFFECT OF MAGNIFICATION ON TARGET RECOGNITION FROM A MOVING TANK

Military Personnel Research Committee, Report No. BPC 44/366, PL 146, July, 1944, 13pp., (confidential).

This report establishes the fact that high magnification is not necessarily a disadvantage for observation from a moving tank. Data were obtained by measuring the range of vision (for black rotatable L's of graded sizes on a white target screen) possible with instruments of different magnification for varying conditions of vehicle speed, types of ground, and forms of brow-pad and mounting used. The findings are: (1) Binoculars, rigidly mounted and provided with a brow-pad, may, in a vehicle moving slowly on level ground, allow target recognition at 2½ to 3 times the range possible with the naked eye when stationary. (2) The range of target recognition from a moving vehicle rises with the magnification of the instrument until this reaches 4X, and then remains about constant for magnifications between 4X and 10X, the disadvantages of vibration at higher magnifications being offset by the advantages of magnification.

16. COLORED LIGHT IN MAP READING

Pochin, E. E., and Wright, H. B., Military Personnel Research Committee, Report No. BPC 44/362, PL 144, July, 1944, 4pp., (restricted).

The advantage gained in protecting night vision by the use of red or amber light for map reading in tanks is outweighed by the effect of such light on current colored maps. Selected maps were examined by six subjects from a distance of one foot at illuminations of 0.3 f. c. with "white", amber, and red light. Red light makes red markings invisible; amber light renders blue indistinguishable from black. Color contrasts are greatly reduced by both red and amber light, and each also causes other defects.

17. MOVEMENT OF THE HEAD AND EYES IN ALL ROUND VISION

Pochin, E. E., and Wright, H. B., Military Personnel Research Committee Report No. BPC 44/359, PL 143, July, 1944, 5pp., (restricted).

In order to determine the best positions for periscopes in an all round vision cupola or similar device for tanks, six subjects were examined while seated, holding two handles, simulating those of a commander's cupola. Measurements were made of (1) position of

nasion, (2) direction of glance, and (3) angle between this direction and that of the forehead after a quick glance toward each of twelve selected positions to one or the other side of the forward direction. (Three subjects to each side.) A similar procedure was employed to examine four of these subjects while standing with feet placed in marked positions nine inches apart. In glancing to the side or to the rear, the head and eyes move in the following way: (1) The eyes take up positions which lie on a track which is roughly circular when the subject is standing or oval when seated. (2) The line of sight always passes through or near a central point which is 1 inch in front of the center of the seat or is above the center of the feet when standing. (3) Turning of the eyes in the head accounts for a fifth (subjects standing) or a quarter (subjects seated) of the total deviation of the line of sight from the forward direction. Periscopes in an all round vision cupola would thus face towards the center if otherwise possible.

18. EFFECTS OF HIGH PRESSURE OXYGEN ON VISION

Haldane, J. B. S., and Kalmus, K., Royal Naval Personnel Research Committee, Report No. RNP 44/112, UPS 46, May, 1944, 5pp., (secret).

Repeating and extending an American study, the investigators found that when breathing oxygen at high pressures, a number of subjects developed a contraction of the visual field, though less than that reported previously. Partial failure of night vision and of color vision were sometimes observed. These effects are thought to be of little operational importance.

19. THE MARKING OF AIRCRAFT INSTRUMENT DIALS

Mercer, E. H., Australian Technical Paper No. 815, April, 1944, 5pp., (secret).

This investigation of the effect on different kinds of dial markings of the three common lighting systems, white, ultraviolet, and red light recommends the adoption of a paint which fluoresces orange under ultraviolet as the most suitable single type for use under all types of illumination.

20. EFFECT OF ANTI-MALARIAL DRUGS ON DARK ADAPTATION

RAAF, Flying Personnel Research Committee, Report No. FR 72, Received D. C., July, 1944, 5pp., (secret).

Dark adaptation tests were performed on a group of 33 air-crew trainees before and after taking Quinine, Atebrin, and "A S 1" in suppressive doses. No adverse effect on dark adaptation was observed with any of the drugs used. An apparent small improvement in score after taking the drugs was probably the result of learning factors.